

Intel Technology Briefing

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What are we talking about?

- **An important research achievement**
- **Demonstration of world's smallest and fastest CMOS transistors**
- **Demonstrates no fundamental barriers to Moore's law scaling through middle of decade**
- **Will allow microprocessor speeds to approach 10GHz with <1 Volt operation**

Why are transistors important?

- Transistors are the engine that drive microprocessor performance
- Goal:
 - High drive current
 - Allows millions of transistors to quickly talk to each other
 - Smallest size
 - Allows maximum density of transistors per device
 - More transistors = more processor capabilities
 - Allows lowest cost per transistor
 - Low operating voltage
 - Allows low power and long battery life

Moore's Law drives R&D

- Our goal:
 - 30% shrink in transistor size every 2 years
 - Delivers 2x die per wafer
 - Delivers 1/2x transistor cost
 - 30% transistor performance improvement
 - Delivers 2x speed

Intel Delivers Advanced Technology into Products

- Intel has a fully integrated R&D path
 - Universities & Consortia
 - Internal Research
 - Development
 - High Volume Manufacturing

Manufacturing Process Evolution

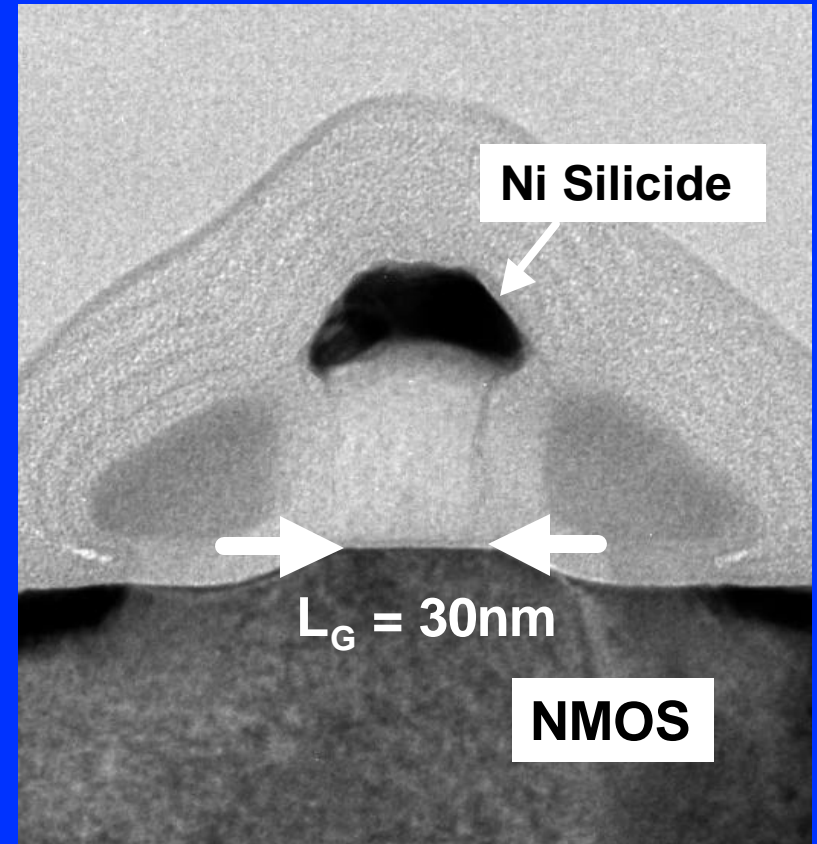
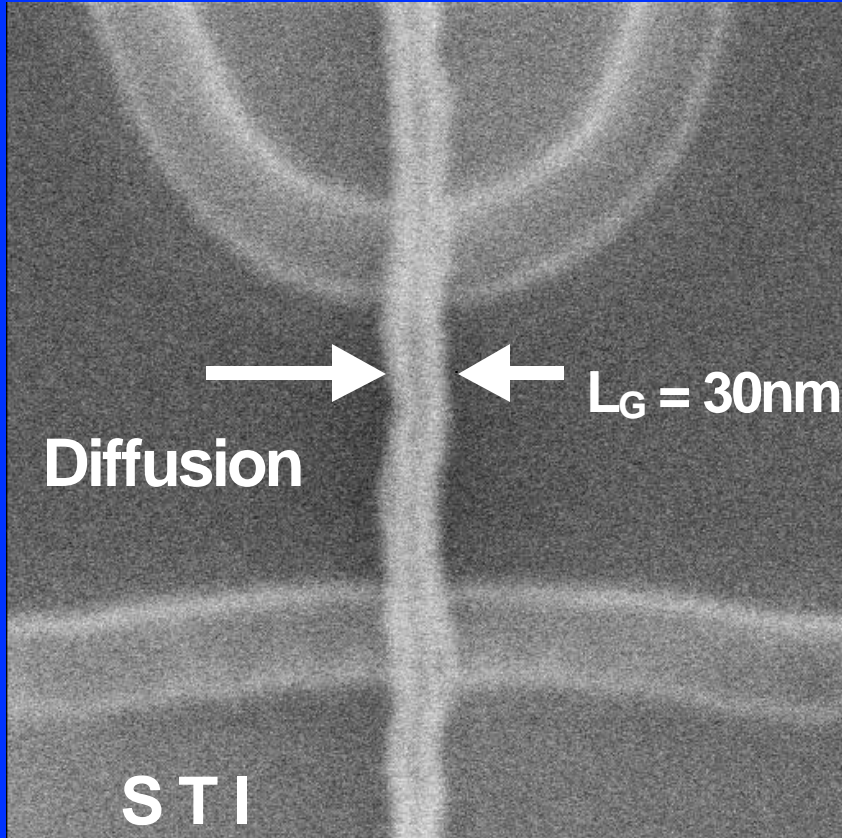
	Actual					Forecast	
Process name	<u>P852</u>	<u>P854</u>	<u>P856</u>	<u>P858</u>	<u>P860</u>	<u>P1262</u>	<u>P1264</u>
Production	1993	1995	1997	1999	2001	2003	2005
Generation	0.50	0.35	0.25	0.18	0.13	0.10	0.07 mm
Gate Length	0.50	0.35	0.20	0.13	0.07	0.05	0.03mm

This work

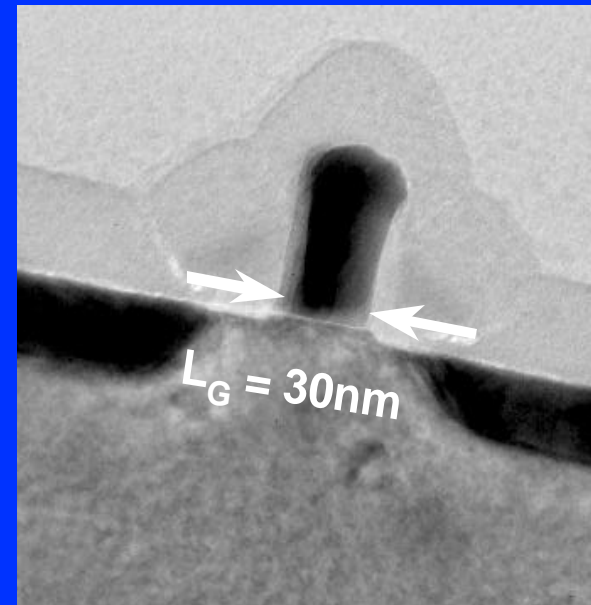
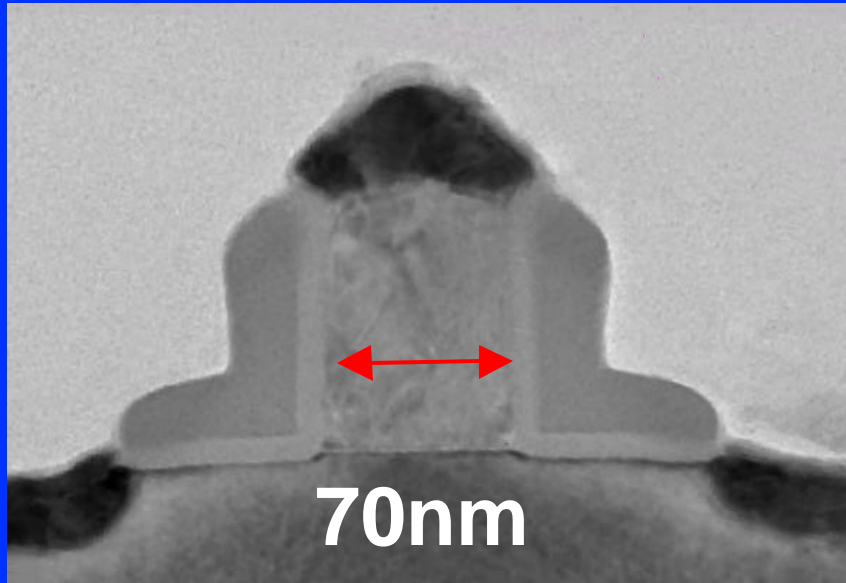
*New generation every 2 years -
One reason why Intel is in leadership position*

Note: 0.03mm = 30nm

30nm Physical Gate Length Transistor



Nano-technology on silicon products: Intel leads in production and research



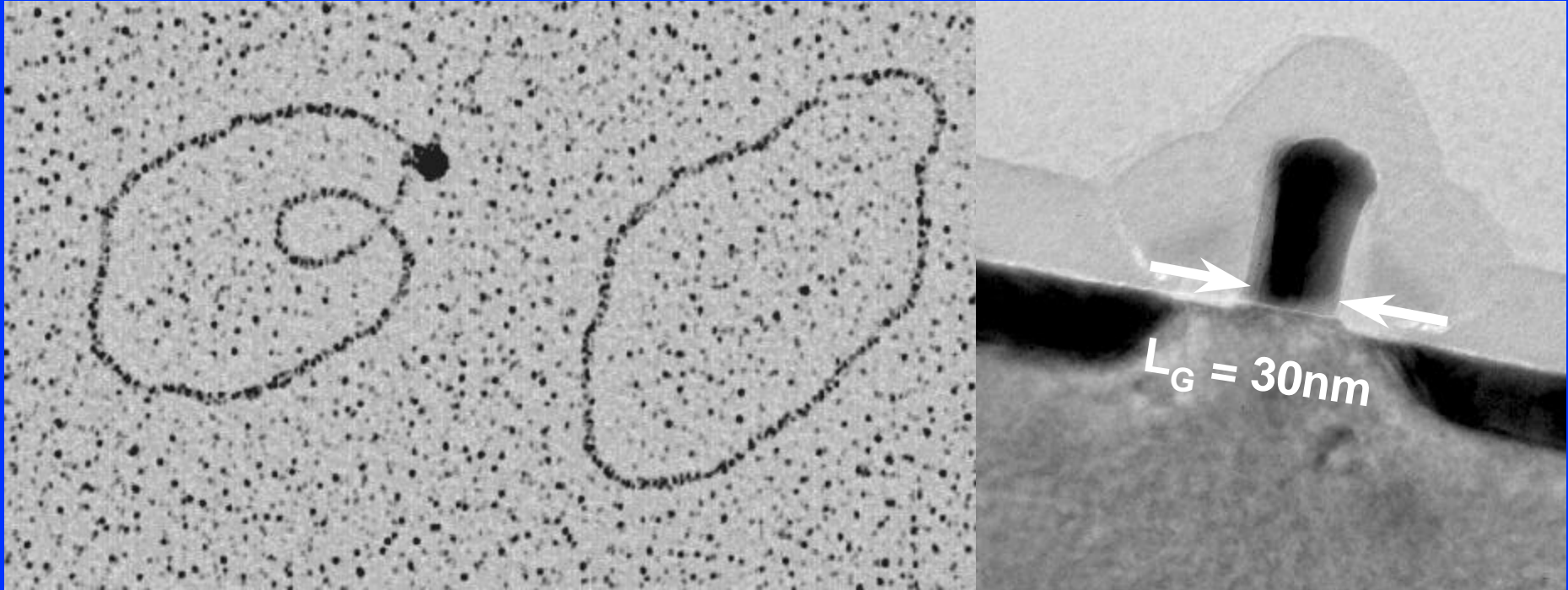
World's highest performance transistor in
manufacturing: P860 Technology

0.13 micron generation

Research is two generations
ahead of manufacturing

0.07 micron generation

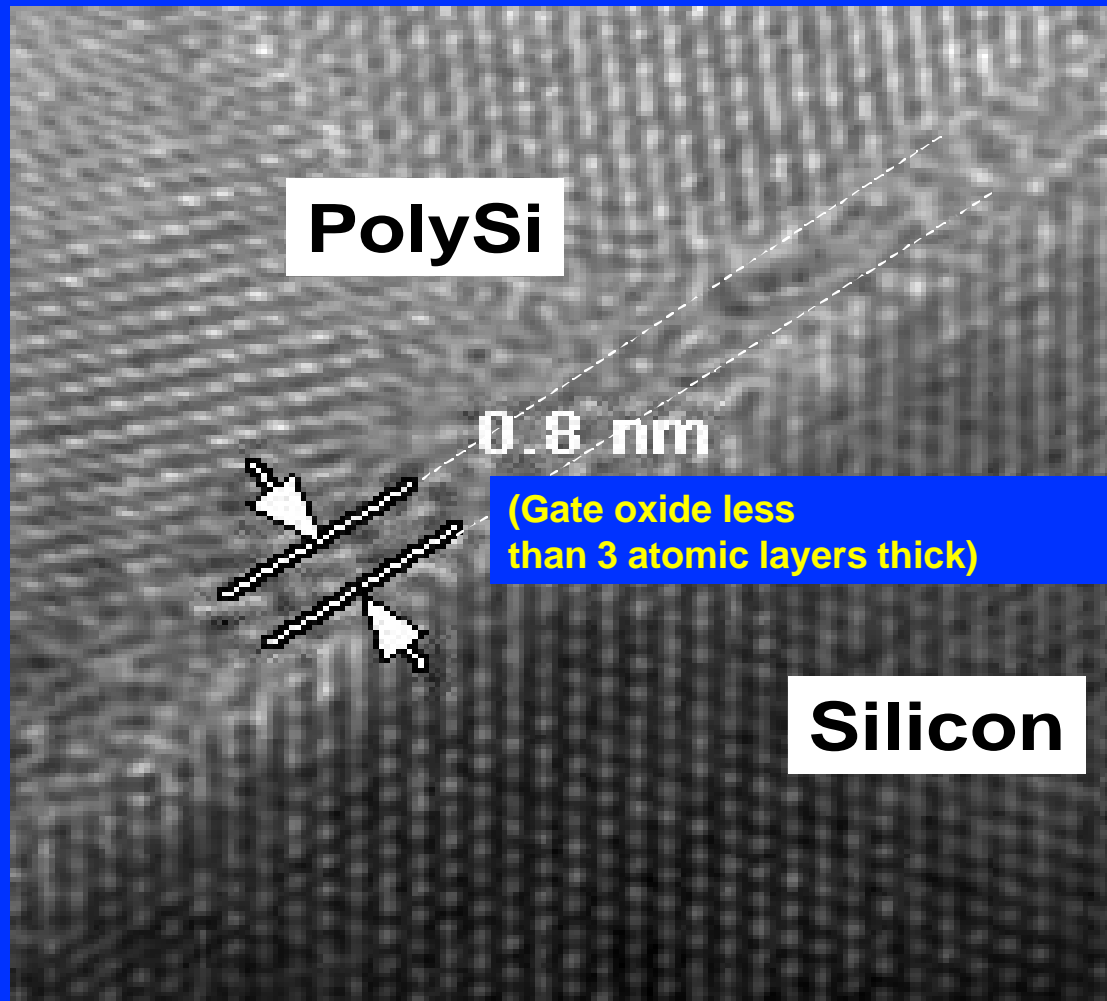
Transistors as small as DNA



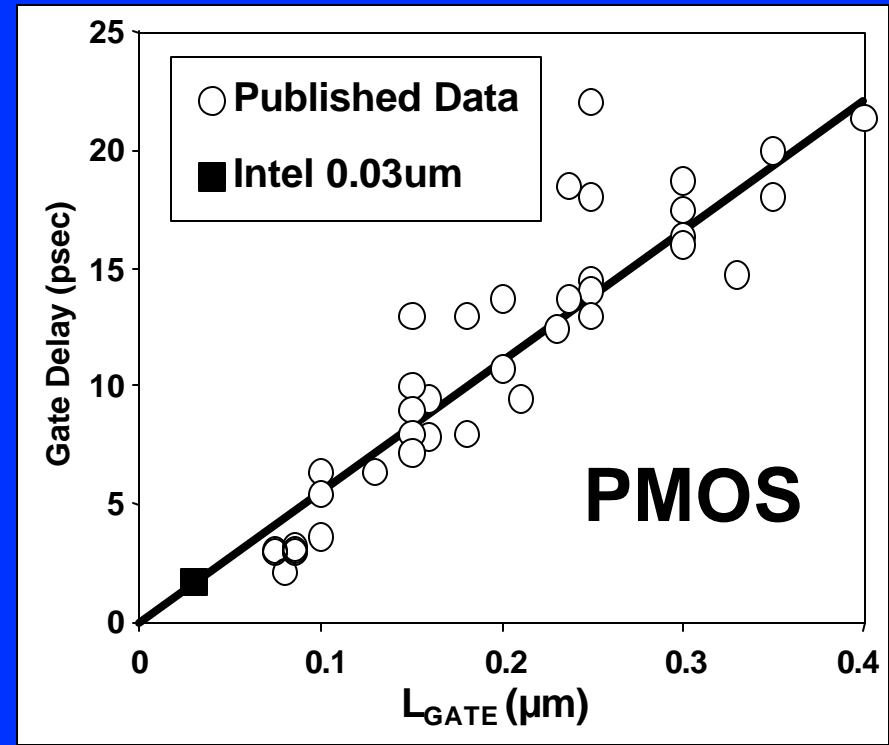
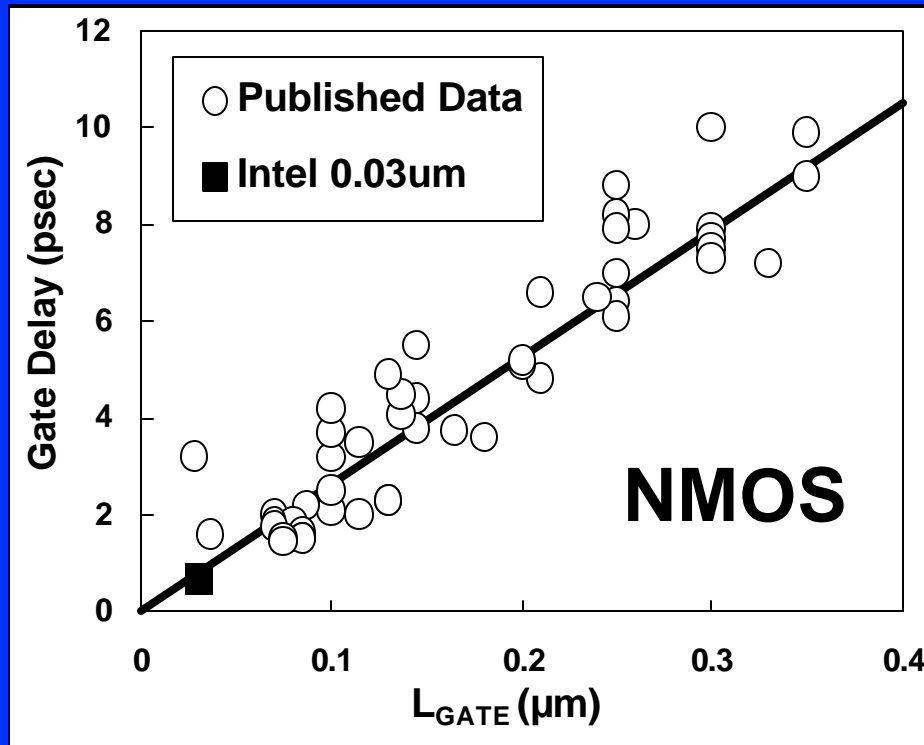
10nm Gold particle attached to Z-DNA antibody
John Jackson & Inman. Gene 1989 84 221-226.

30 nm Intel
Research Transistor

Gate Oxides as Thin as Atoms



Individual Transistor Speed Above 500 GHz



- Intel transistor performance continues to lead industry

30nm Transistors: Not Ready for Prime Time

- Researchers pushed 2 generations beyond manufacturing capability
 - Novel phase shift mask patterning
 - Atomically thin gate oxides
 - Aggressively thin gate electrode and junctions
 - < 1 volt operation
 - New electrical measurement capability

Intel Research

- **We still have not found a fundamental barrier to extending Moore's law**
- **Ongoing research includes:**
 - **EUV Lithography**
 - will print below 50nm
 - **New transistor materials**
 - high k gate dielectrics
 - **New transistor structures**
 - more current / area

10 GHz microprocessor: Possible applications

- Real time computation of speech
 - complex vocal commands to computer
 - simultaneous translation of languages
 - with interpretation of gestures
- Allows computation of images
 - allow user to select and find an image
 - example: find a sweater on line
 - 3 dimensional HDTV quality graphics

Intel's Technology Edge

- Research to Development to Manufacturing pipeline
- Fastest transistors in the industry
- Advanced Lithography
- Voltage scaling for low power

Intel's logic technology continues to lead the industry

Q & A

- For information on Intel's silicon technology, please visit the new Silicon Showcase at www.intel.com/research/silicon
- More 30nm transistor details will be available at the IEEE International Electron Devices Meeting (IEDM) in San Francisco on December 11